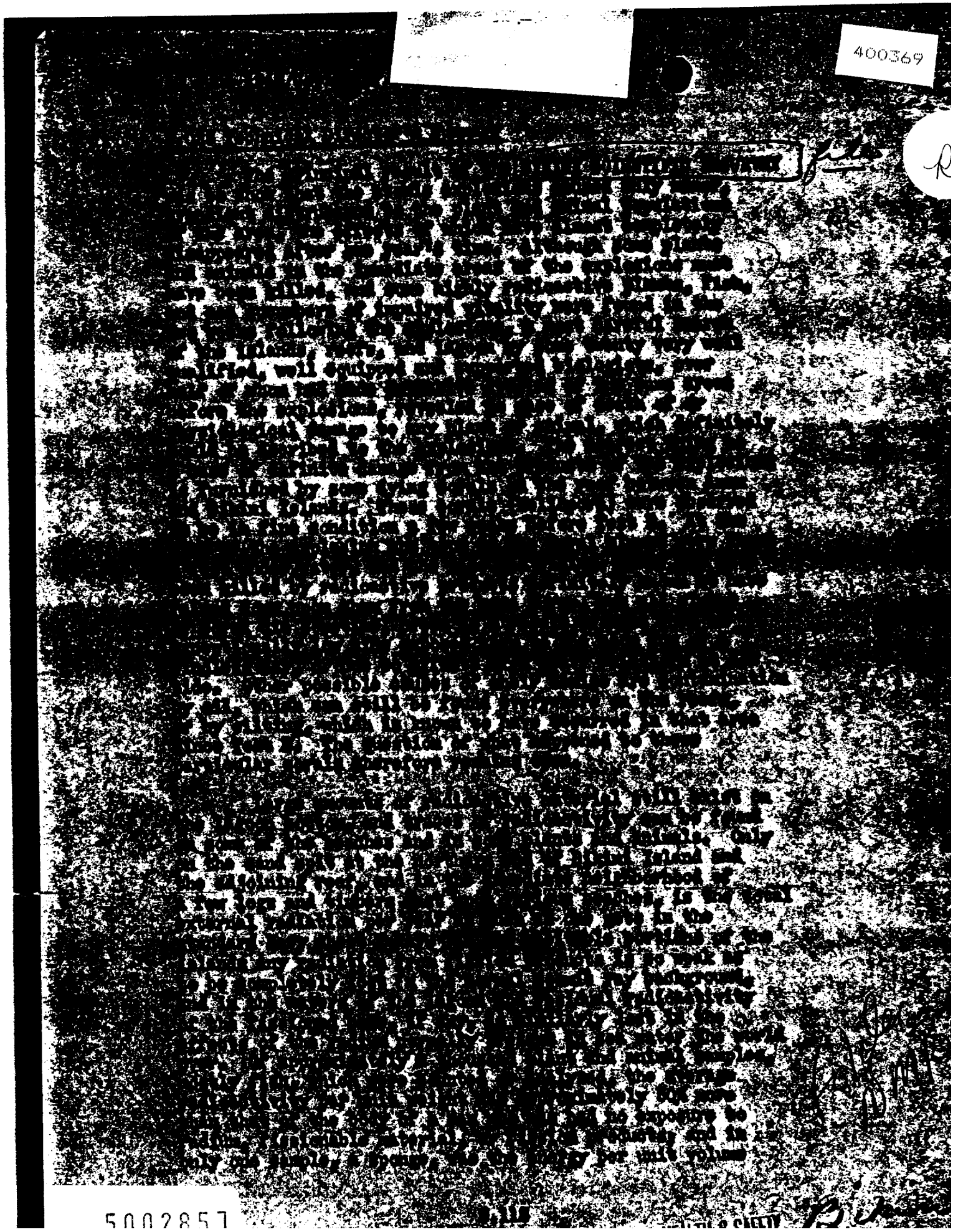

being received from radioactivity as much as it would have been from the accepted tolerance of external radiation, 0.1 r/24 hr. Other than fish, no food product was found which contained more than twice the normal radioactivity of human flesh. No detectible amount of Pu was found in any food product. The conclusion of the writer, from the above figures and others known to him, is that the hazard from radioactivity to an adult living continuously on Bikini Atoll indefinitely, subsisting entirely on local food products, would be less than the hazard of a single journey by air from there to the United States. When it is remembered that the two dangerous long-lived fission products, Sr and Ba, are not now present at Bikini, that the fission-product activity still present will have decayed to about 10% of its present value after one more year, and that of food eaten somewhere between 1% and 10% normally is retained by the body, it becomes obvious that after a few more years these islands will not constitute a radioactive hazard to anyone. As will be shown in more detail in the accompanying reports and below, substantially the same close localization of the radioactivity and relative immunity of surrounding areas from the radioactive effects of atomic bomb explosions may be expected on the land and in the waters of the United States.

The foregoing paragraphs constitute a brief summary of those conclusions of military significance which have accrued from the BIKINI SCIENTIFIC RESURVEY. The accompanying reports give the detailed data in the words of the different scientists who obtained it. Some of these are discussed in detail below.

As CHILTON (APA-38) crossed the sill of Enyu Channel we were disappointed to observe that the water, instead of being marvelously clear, as it had been when the first units of Task Force One entered the lagoon, was as opaque as that off Point Loma, and the writer, at least, concluded that something sinister had indeed occurred. It was found difficult to explain this change, however, on grounds connected with radioactivity. It was known that immediately after Test B there was a large increase in the bacterial population, probably due to nutrients from animals killed by the explosion, and that this might later have been reflected in an increase in the plankton content of the water; but when it was calculated that even the large contribution of Task Force One to the nitrogen and phosphorous content of the water amounted to less than 1% of what was there to start with this idea was abandoned. Late in the summer it was discovered that bacterial levels had resumed their pre-explosion status, and the ghost of bacterial increase was laid to rest. Then some of us remembered that even before Test A the water had

become definitely and progressively more opaque. At the time, this had been thought due to contamination by the Task Force, but when the above-mentioned calculation showed the fallacy of this reasoning, we began to wonder whether the effect might not be seasonal, and associated with the dropping off of the Trades. Four leading natives from the former population of Bikini were brought back, told to observe and record everything that had changed, and taken on a tour of all the islands. They recorded in wearysome detail all the new construction, and found some papaya plants which may have grown from seeds left by Task Force One, but said nothing about the water, even after they had been chivvied in and out of the surf and over reefs until they asked for mercy. They were then asked leading and finally direct questions about the water, but would not concede that it was different from what it always had been. This seemed to establish the effect as seasonal, but recourse was had to other controls.

The water at the southern end of Kwajalein Lagoon, away from the harbor area, was clearer than that of the windward end of Bikini, but not remarkably so. The water at the windward end of Rongerik Atoll was definitely much clearer than that of the corresponding position at Bikini, but even at Rongerik, when a sea was formed in the lagoon by a strong southerly wind and surf beat upon the beaches, the water rapidly became opaque and there was some silting. The conclusion is that the relatively greater opacity of the water at Bikini during the period of the resurvey was due to the heavy swell which enters through Enyu Channel at this time of year, but which is almost completely absent in the winter season when the Trades are steady. The other atolls do not have a large opening to the south and are much less distrubed by the summer swells. Although the origin of the turbidity seems well disposed of by the above observations, it would be desirable to have monthly determinations of water transparency made at the same location in the target area over a period of a year.

On the basis of the chemists' work some detail can now be added to the phenomena of the Baker explosion. Within a tenth of a second after the explosion some 275-day Cerium 144, which is one of the more abundant and troublesome long-lived isotopes, had been formed as the end product of a fast radioactive chain beginning with Xenon 144. Under the great heat and pressure still prevailing, this was mineralized in a way not possible in a reasonable amount of time in the laboratory, to an extremely insoluble and hitherto unknown form, which in all probability can never be absorbed by plants or animals. Within a few minutes a large fraction of all the fission products which ultimately remained in the area were in the water of the lagoon; an exception being 53-day Strontium 89, another long-lived substance, some of which was

fell in the form of [illegible] [illegible] and was carried to the bottom [illegible] of the area of precipitation. The result was that only about half the amount of Strontium 89 finally produced was deposited on target ships. Within a few minutes all the radioactive products which remained in the lagoon were in the water, which was turbid with debris from the bottom and very finely powdered. Photographs taken shortly after the cloud cleared away show an unsymmetrical patch of milky water about the size of the target array. All the fissionable material from the explosion and the following long-lived fission products, Yttrium, Zirconium, Columbium, Antimony, Praseodymium, Element 61, and Europium, as well as many short-lived fission products, were quickly and permanently adsorbed on the suspended material and carried to the bottom, where all but an insignificant fraction still are. Thirty-three year Cesium was not so adsorbed because of the large quantity of the chemically similar element Sodium already present. Twenty-five year and [illegible] lived radio-Strontium was not adsorbed because the relatively large amount of chemically identical neutral [illegible] normally present in sea water had saturated the surface of the adsorbents. Only a small fraction of the various radioactive Ruthenium isotopes was carried down because of the tendency of this element to form complex anions with [illegible] [illegible]. More than 99% of these [illegible] had been [illegible] [illegible] effect of diminishing the amount of the [illegible] -day Yttrium 91, which otherwise would have been a more significant contributor to the present activity of the bottom.

The radioactive materials carried down by the process just described are by no means evenly or symmetrically distributed on the bottom; the details of the distribution are so complex that only a rough qualitative estimate of the total radioactive material on the bottom has been possible. The greater part of the material was deposited near the center of the target array, but patches of [illegible] forty-fold higher activity per unit weight are found farther out, and the data suggested that the most active material was deposited near the outer edge of the [illegible]. [illegible] the most active deposits are at the surface of the bottom, but in some places rich deposits are covered by [illegible].

At the present time there [illegible] burrowing [illegible] actively [illegible] and [illegible] the highly radioactive [illegible] [illegible] where bacteria [illegible] most of the active material to the [illegible] available to plants which grow on the [illegible] are eaten by small fish, which [illegible] almost all the radio-active material through the [illegible]. Small fish with the small

over the material found in its gut; most of the activity was in its liver. No other fish showed gross concentration, although about a third showed a greater concentration in the liver than in the gut.

The marked concentration of radioactivity by plants five days after Test B, and the reverse effect a year later, undoubtedly are reflections of the different identities of preponderent radiators at the two times. Radiobromine, Rubidium, Ruthenium, Iodine, 13-day Cesium (33-year Cesium, though present at that time, was an insignificant contributer), Strontium, and Barium, none of which were present in appreciable amounts a year later, would not have been carried to the bottom by the sediment. Overstreet and Jacobsen (CH 5588) have shown that of the radioelements Strontium, Yttrium, Cerium, Zirconium, and Columbium, only the first was appreciably concentrated by dwarf pea plants.

It will be seen from the above considerations, that although specific cases of concentration of radioactivity by plants and animals do occur, the gross effect of biological processes is overwhelmingly in the direction of dilution. Though it is possible that after an atomic attack a particular warehouse might be made more radioactive than the surrounding country, the main effect of plants and animals would be to hasten the time when contaminated areas could be returned to normal use.

One of the most feared effects of radioactivity is the possibility of producing monsters by genetic changes. At Bikini more than a thousand species of organisms have been exposed to unprecedented amounts of radioactivity, and many of them have reproduced through several generations since. A most careful search of the area by competent biologists, ichthyologists, botanists, and an entomologist, in the course of which tens of thousands of specimens were examined, failed to reveal a single abberant form. It would seem that this danger is illusory.

The Experimental Biology Group, particularly, was on the lookout for effects of radiation on those physiological processes where it was considered most likely to show -- reproduction, metabolism, and enzyme activity. The only effect found was an increase in catalase activity in certain algae. This was believed beneficial to the organisms in question.

In using the results of the Bikini resurvey, with other information, in planning the defense of the United States, two points need special consideration. At Bikini three abundant long-lived fission products -- Strontium, Cesium, and Ruthenium -- were not carried down by the mud because sea water contains abundant material in solution to hold them

back. In fresh water and on the land this will not be the case, and the area of heavy contamination will be even more sharply limited and defined than at Bikini. The second point is that in heavily contaminated fresh water or land areas 28-year Strontium and 33-year Cesium, not now present at Bikini, will maintain significant external radiation levels long after the long-lived fission products now present at Bikini have decayed into the cosmic-ray background.

Outside the areas of heavy contamination in land or fresh-water masses there will be a gradual spread of traces of wind, animal, and crop-born radioactivity, and these probably will be detectable over a wide area for some time, as they now are at Bikini. Realistically considered, these traces will offer no hazard at all comparable to the danger of driving an automobile, crossing the street, or living in a house with live electric wiring. Even those who might have qualms about eating fish and coconuts from Bikini Atoll have the comfort knowing that there are valuable crops for every kind of soil which could be profitably harvested and used, even though they reeked of Plutonium. Whiskey from contaminated corn would be just as harmless as that from the undefiled mountains of Kentucky. Contaminated wheat, barley, potatoes, and rice also could be used in the fermentation industries which now take appreciable fractions of the output. Sugar from contaminated cane or beets could be served on the table without any reservations. The loss to agriculture will be confined to heavily contaminated areas -- probably less than five square miles per bomb.

One of the avowed objects of the resurvey was to conduct researches of purely scientific interest, particularly those begun by Task Force One. Over three quarters of the man-hours of the mission, and well over that proportion of the funds, were so used. Although nothing particularly new or startling was discovered, considerable data was added to the fund of knowledge concerning the geology, oceanography, and biology of these islands. A good picture of the work may be had from the accompanying reports, but final appraisal must await publication in the standard scientific journals. It is considered possible and desirable to continue this work at a lower rate and higher efficiency. A suggestion as to how this might be done is given at the end of this Section.